

# How the market judges bank risk

*Elijah Brewer III and Cheng Few Lee*

The risks that a bank faces can be judged by looking at such accounting data as asset composition, quality, and liquidity; capital adequacy; and earnings. Financial theory suggests that the risk sensitivity of a bank can also be judged by examining the returns required by financial markets—specifically the market for bank equities. Using both accounting and market data, we compare the financial characteristics of bank holding companies from different parts of the country. We find that there is a significant but imperfect correlation between accounting-based measures of equity risk and market-based measures of equity risk. We also find that there are regional differences in the market response. For example, the equities of New York City bank holding companies exhibit more sensitivity to certain kinds of risk than do Chicago, California, or regional bank holding companies. Finally, we find that regional differences in branching laws have an important impact on bank equity risk through their effect on a bank's reliance on purchased funds.

Economic risks—as reflected in uncertainty regarding economic growth, inflation, and interest rates—have differential regional impacts because regulation and market forces have led banks to develop different exposures to risk. Regional variation in regulations governing branching, mergers, and acquisitions influence the ability of banking organizations to control their risk. For example, some banking organizations have placed a heavy reliance on purchased funds because branching restrictions make it difficult for them to develop a broad deposit base and thus have access to more stable sources of funds. On the asset side of the balance sheet, geographic constraints and restrictions on mergers and acquisitions tend to limit the ability of some banking organizations to engage in risk-reducing diversification of their loan portfolios. Depending on its part of the country, a bank may be more sensitive to certain kinds of risk.

## **Risk and bank equity values**

In structuring their investment portfolios, bankers choose their exposure to credit, liquidity, and interest rate risks with the expectation of earning a return commensurate with the expected levels of risk. Research on bank failure indicates that bank risk can be evaluated using four key variables: asset quality, liquidity, capital adequacy, and earnings.<sup>1</sup>

Asset quality is particularly important for banks because they assume both a credit and an interest rate risk exposure on most of their assets. Because banks are highly leveraged, large loan or security losses can bring insolvency. Large fluctuations in interest rates can cause great appreciation or depreciation in the value of long-term fixed-rate assets. The quality of assets will be affected both by management's control over its credit review function and by economic conditions. For example, banks may purchase long-term securities that are profitable if interest rates fall or remain stable but could lead to losses if interest rates rise (assuming no hedging). Or, a decline in credit quality can lead to write-offs and reduced earnings in the loan portfolio. As a consequence, the riskiness of bank equity and the probability of negative net worth will be higher, the lower a bank's asset quality.

Bank equity values are also sensitive to liquidity risk. Liquidity risk is the risk that a bank will be unable to fund its assets without paying a premium over the rates paid by other banks on similar liabilities. Banks that depend on short-term deposits and purchased funds are more likely to face a liquidity crisis when asset quality deteriorates. In an extreme case, a bank may be unable to raise funds in private markets at any cost. Although liquidity is rarely the original cause of financial problems for banks, it is usually a firm's inability to meet liquidity needs that signals its imminent end.

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Elijah Brewer III is an economist at the Federal Reserve Bank of Chicago. Cheng Few Lee is professor of finance, University of Illinois, Champaign-Urbana.

To protect against liquidity risk a bank can lengthen the maturity of its liabilities or increase the marketability of its asset portfolio, thereby giving itself the flexibility to respond to adverse developments in the markets for its liabilities by selling assets. However, because the liabilities for which maturity can be adjusted most readily typically are fixed-rate instruments, the reduction in liquidity risk simultaneously alters the bank's exposure to interest rate risk in the direction of greater losses (or smaller gains) in the event of declining interest rates. As a result, the net effect of such an adjustment on overall bank risk can only be determined empirically.

Bank equity values are also sensitive to the level of book capital relative to total assets. Regulators define a bank's capital as the difference between the book value of its assets and liabilities.<sup>2</sup> Other things equal, a lower ratio of capital to assets depresses the bank equity values because it increases the probability that temporary losses will reduce the bank book capital below the level needed to prevent the Federal Deposit Insurance Corporation from closing the bank.

Bank equity values are affected by the earning power of its assets—the net rate of return on assets. The rate of return on assets influences the bank's ability to attract equity capital. Other things held constant (including asset risk), the higher the rate, the greater the amount of equity capital supplied to the bank. The rate of return on assets influences also the cushion available to absorb losses from bank operations or defaults on assets. Other things held constant, the higher the rate, the more losses the bank can take before its capital position is threatened. Bank risk is affected not only by the rate of return on assets but also by the variability of the rate of return on assets. Banks with highly volatile rates of return on assets will have highly volatile stock prices.

The ratios shown in Table 1 indicate several facets of large bank holding company financial positions by geographic areas. As expected, the book capital-asset (Book value in Table 1) ratios for money center bank holding companies in New York City, Chicago, and California were lower than that for regional bank holding companies. Within the money center category, New York City banking firms had the lowest and Chicago bank holding companies the highest book capital-asset ratios.

Other things held constant, lower book capital-asset ratios at money center bank holding companies indicate a greater exposure to the risk of failure, or a smaller cushion to absorb losses from operations or defaults on assets. These findings were similar when using market capitalization-asset (Market value) ratios, with the exception of California bank holding companies. California bank holding companies had higher market capitalization-asset ratios than those bank holding companies located in other areas. However, market capitalization-asset ratios are in general lower than book capital ratios. The simple rank correlation between book capital ratios and market capitalization ratios is 0.70, and it is significantly different from the value of one for perfect correlation. The results suggest that the risk exposure ranking based on market values may imply different exposure rankings as well as a cushion available to absorb losses than ranking based on book values.

Money center bank holding companies finance their higher loan-to-asset (Loans) ratio by placing greater reliance on purchased funds than bank holding companies in other areas.<sup>3</sup> California bank holding companies have on average higher loan-to-asset ratios than other money center bank holding companies, although California bank holding companies reliance on purchased funds is significantly lower, reflecting differences in branching and other regulations. The implications of these ratios for bank risk are complex. The lower purchased funds ratios suggest that those bank holding companies are less exposed to liquidity risk. However, higher loan-to-asset ratios tend to indicate a greater exposure to credit risk.

The higher after tax net return on assets (ROA) at regional bank holding companies together with their less risky profile indicates a larger cushion to absorb losses before their capital position is threatened. Regional bank holding companies' capacity to absorb charge-offs is evident from the ratios in Table 1. Regional and California bank holding companies have both a higher ROA and, with the exception of Chicago bank holding companies, a higher ratio of loan charge-offs to total assets than New York City bank holding companies. The net effect of these various accounting ratios on bank risk and on the return a bank must earn to compensate stockholders for bearing this risk can only be determined empirically by



**Table 1**  
**Selected financial ratios for large bank holding companies**  
**(average values 1978-1983 as a percent of total assets)**

Money Center	Book value	Market value	Loans	Purchased funds	Loan charge-offs	After tax net income	
						Mean	Standard deviation
California (5)	0.0447	0.0398	0.6158	0.4451	0.0063	0.0059	0.0013
Chicago (4)	0.0458	0.0274	0.5562	0.6180	0.0061	0.0042	0.0011
New York City (8)	0.0404	0.0265	0.5525	0.6006	0.0040	0.0054	0.0009
Other Areas (27)	0.0556	0.0363	0.5285	0.3205	0.0069	0.0062	0.0022

Accounting data from yearend reports filed with the Federal Reserve System by large bank holding companies. Price data used in the market value calculations came from Automatic Data Processing, Inc. The share data came from *Moody's Bank and Finance Manual*, Vol. 1, 1978-1983.

relating them to market-based measures of risk sensitivities estimated from stock price data.

### Methodology and data

Modern finance theory suggests that bank risk sensitivity can be measured by analyzing stock market returns. Bank equity values are sensitive to all the factors that affect the overall stock market as well as to factors specific to the banking industry. For example, banks are sensitive to "earnings risk" through possible defaults on their loans and investments, changes in loan demand, and potential variability in growth and profitability of their non-portfolio operations. Bank equity values are also sensitive to movements in interest rates because banks typically fail to match the interest sensitivity of their assets and their liabilities. As a result, movements in interest rates affect the market value of each side of the bank's balance sheet and both its net worth and stock values.

The multi-index market model is widely accepted as a characterization of the return-generating process for common stocks.<sup>4</sup> This model is an extension of the common single-index market model in which capital market risk sensitivity can be represented by the equity "beta," or the measured sensitivity of the firm's equity return with respect to the return on the market-wide portfolio of risky assets.

The multi-index market model is employed in this article to capture other determinants of individual stock returns. This study

examines two other determinants of bank stock returns: changes in the prospects of a particular industry that would have effects on the entire set of firms in that industry, but not stocks in general, and unanticipated changes in interest rates.

Our multi-index market model takes the following form

$$r_{j,t} = \alpha_j + \beta_{1j} r_{M,t} + \beta_{2j} r_{I,t} + \beta_{3j} r_{F,t} + \varepsilon_{j,t} \quad (1)$$

where  $r_{j,t}$  is the rate of return on stock  $j$  in excess of the risk-free rate of interest;<sup>5</sup>  $r_{M,t}$  is the rate of return on the market portfolio in excess of the risk-free rate of interest;  $r_{I,t}$  is the rate of return on the banking industry stock index in excess of the risk-free rate of interest;  $r_{F,t}$  is a measure of unanticipated changes in interest rates; and  $\varepsilon_{j,t}$  is an error term. In the linear regression  $\alpha_j$ ,  $\beta_{1j}$ ,  $\beta_{2j}$  and  $\beta_{3j}$  are parameters to be estimated. The value of  $\beta_{1j}$  indicates the riskiness of stock  $j$  relative to the market as a whole;  $\beta_{2j}$  can be interpreted as representing the industry sensitivity of bank  $j$  stock; and  $\beta_{3j}$  measures the effect of unanticipated changes in interest rates on the stock returns of bank  $j$ .

Equation (1) was estimated over the period January 1978 through June 1984 using daily returns data (dividends and capital gains) for a sample of 44 bank holding companies.<sup>6</sup> Eight of these bank holding companies were located in New York City, four in Chicago, five in California, and 27 were located in other geographic areas. The 1,642 daily return observations were pooled, yielding 13,136 observa-

### Measuring the market's response

The return on the market portfolio was measured by the return on a value-weighted portfolio of the firms on the New York Stock Exchange and American Stock Exchange obtained from the Center for Research in Security Prices (CRSP) data base.

Data from Automatic Data Processing Inc., was used to construct a bank industry stock market index. A total of 71 bank holding companies were included in the sample. For each bank holding company, the aggregate market value of the stock was computed each day by multiplying the share price by the number of common stock shares outstanding. For days on which dividends were paid, the price was adjusted upward by the amount of the dividend for computing the market value that day only.\* The bank industry stock index was computed by summing the individual bank holding company market values and then dividing by the value of that sum in 1981.

Interest rates on U.S. Treasury obligations were used to ensure that estimation of the relation between stock returns and unanticipated changes in interest rates was free from "contamination" resulting from changes in default premiums. Three-month Treasury bills were used because they are also pure discount instruments, that is, they bear no coupons.

Unanticipated changes in interest rates were measured by the difference between the actual 3-month Treasury bill rate at time  $t$  and the forward 3-month Treasury bill rate embedded in the yield curve at time  $t-1$ .\*\* The forward rate incorporates expectations and, in equilib-

rium, this rate is the market forecast of the expected rate for period  $t$ .† If interest rates are lower than anticipated in time period  $t$ , bank equity values may increase or decrease, depending upon the bank's asset/liability maturity mismatch.

\*This procedure is similar to that used to construct the CRSP value-weighted market index. Dividends are included in the CRSP value-weighted index.

\*\*A number of researchers have measured unanticipated changes in interest rates by the change in the 3-month Treasury bill rate from the previous period,  $({}_tR_3 - {}_{t-1}R_3)$ . Booth and Officer (1985) have shown the experiments using this measure of unanticipated changes in interest rates led to marginally worse fits for their regression equations, smaller interest rate sensitivity estimates and no appreciable differences as to the statistical significance of any of the other coefficients in the equations. For these reasons,  $({}_tR_3 - {}_tF_{3,t-1})$  is used as a measure of unanticipated changes in interest rates rather than  $({}_tR_3 - {}_{t-1}R_3)$ . The forward three-month Treasury bill rate embedded in the current term structure of interest rates can be calculated as follows:

$${}_{t+1}F_{3,t} = \frac{(1 + {}_tR_6)^2}{(1 + {}_tR_3)} - 1$$

where  ${}_{t+1}F_{3,t}$  is the forward three-month Treasury bill rate embedded in the yield curve at time  $t$ ;  ${}_tR_6$  is the current yield on a six-month Treasury bill in time  $t$ ; and  ${}_tR_3$  is the current yield in time  $t$  on a three-month Treasury bill.

†See Hicks (1946) for a discussion of this point, pp. 135-140; pp. 146-147. Fama (1976), in a more recent study, also makes this point.

tions for New York City bank holding companies, 6,568 observations for Chicago bank holding companies, 8,210 observations for California bank holding companies, and 44,334 observations for the group of holding companies in other areas.

The bank returns data are for bank holding companies. For each of the holding companies included, commercial banking was by far the major activity of the firm. Assets at subsidiary commercial banks accounted for more than 81 percent of the parent bank hold-



ing company assets for each firm in the sample. On average, commercial bank assets accounted for 96 percent of holding company assets, and 63 percent of holding company income.

### Empirical results

Using the pooled data, equation (1) was estimated separately for bank holding companies in each of the four geographic areas using ordinary least squares regression.<sup>7</sup> The results of this exercise are shown in Table 2. The equity values of New York City banks are relatively more exposed to market and industry sources of risks than are California and Chicago bank holding companies. For New York City bank holding companies, the ordinary least squares results indicate that for every one percent change in the return on the market portfolio, bank returns will change 0.81 percent. Additionally, for every one percent change in the banking industry return, bank returns will change by 1.19 percent.

The results in Table 2 also indicate that the equity values of Chicago bank holding

companies are less affected by market and industry risks than are the other two money center banking regions. New York City bank holding company stocks exhibited significantly more market and industry sensitivities than the other two groups of money center bank holding companies.<sup>8</sup>

Although banking organizations outside of the money center areas are significantly less sensitive to market and industry sources of risks, their equity values are significantly more exposed to interest rate risk. The coefficient for the interest rate factor is significantly negative for these institutions.

A negative coefficient on the interest rate variable indicates that higher than anticipated interest rates will cause bank holding company equity values to decline. This implies that over the estimation period the interest sensitivity of assets was, on average, greater than the interest sensitivity of the liabilities for the bank holding companies in the sample. This indicates that only the smaller regional banking organizations have a significant exposure to interest rate risk.

**Table 2**  
**Risk sensitivities of bank stocks**  
**January 1978 - June 1984**

	Intercept	Stock market risk	Banking industry risk	Interest rate risk	$\bar{R}^2$	S.E.E.
Money Center Areas (17)						
California Banks (5)						
OLS	0.0002 (1.086)	0.7423 (37.435)*	0.9116 (31.200)*	0.0019 (0.286)	0.2215	0.0153
Chicago Banks (4)						
OLS	-0.0001 (0.364)	0.6465 (28.374)*	0.7672 (22.848)*	-0.0053 (0.693)	0.1663	0.0157
New York City Banks (8)						
OLS	0.0002 (1.807)***	0.8053 (63.614)*	1.0899 (58.424)*	-0.0030 (0.709)	0.3589	0.0124
Other Areas (27)						
OLS	0.0002 (2.286)**	0.3937 (46.006)*	0.3998 (31.706)*	-0.0228 (7.933)*	0.0677	0.0153

$\bar{R}^2$  is the coefficient of determination corrected for degrees of freedom, S.E.E. is the standard error of estimates, and the numbers in parentheses below the regression coefficients are the absolute values of the corresponding t-ratios. One asterisk indicates that the regression coefficient is significantly different from zero at the 1 percent level. Two asterisks indicate significance at the 5 percent level. Three asterisks indicate significance at the 10 percent level.

## Links between accounting and market measures of risk

As discussed above, commercial bankers, through decisions about uses and sources of funds, determine expected return and an associated level of risk for banks' shareholders. It is possible to test whether bankers' decisions as reflected by their accounting statements are related to market, industry, and interest rate risks of bank equity. We chose to test this proposition by relating those accounting ratios in Table 1 to estimates of market, industry, and interest rate risk sensitivities for our 44 bank holding companies. For each bank holding company, the average value of the accounting ratios was calculated by averaging over annual data for the 1979-1983 period. The market, industry, and interest rate risk sensitivities were estimated separately for each of the 44 bank holding companies over the period January 1978 through June 1984 using daily return data.

The results of estimating the relationship between each market-based measure of risk sensitivity and the accounting ratios are shown in Table 3. Where an increase in a financial ratio would be expected to increase risk, that ratio should have a negative impact on bank sensitivity. The coefficient on the book capital ratio has a negative sign and is significantly different from zero in both the market and industry equations. The after-tax net income-to-assets variable was positive and only significantly different from zero in the interest rate equation. In all three equations, the purchased funds ratio and the loans-to-asset ratio both have a positive sign and are statistically significant. Neither the standard deviation of the after-tax net income nor the loan charge-offs ratio has a statistically significant effect on the three market-based measures of a bank's risk sensitivity.

These results reveal the nature and the degree of impact that certain financial ratios have on banks' market-determined measures of risk sensitivity. Bank risk sensitivities increase when both loans and reliance on purchased funds rise, or when the book capital-to-asset ratio declines. Variations in these three variables explained a surprisingly large proportion of the variation in financial markets' assessments of the risk of bank equity. These results suggest that there is much more information

**Table 3**  
The impact of financial ratios on market-based measures of risk sensitivity (t values in parentheses)

	Market	Industry	Interest rate
<u>Book capital</u>			
Assets	-14.6819 (3.140)*	-16.9681 (2.858)*	-0.4351 (1.298)
<u>After-tax net income</u>			
Assets	22.1074 (1.136)	36.6713 (1.484)	4.6945 (3.364)*
Standard deviation of after-tax net income-to-asset ratio	5.1105 (0.254)	-16.3513 (0.639)	2.2129 (1.532)
<u>Purchased funds</u>			
Assets	0.8498 (4.193)*	1.4813 (5.757)*	0.0532 (3.658)*
<u>Loans</u>			
Assets	0.9441 (2.827)*	1.6802 (3.963)*	0.1014 (4.237)*
<u>Charge-offs</u>			
Assets	12.8053 (0.968)	11.2650 (0.671)	-0.3809 (0.402)
Intercept	0.1925 (0.611)	-0.3050 (0.763)	-0.0990 (4.384)*
$\bar{R}^2$	0.6758	0.7527	0.5116

One asterisk indicates that the regression coefficient is significantly different from zero at the 1 percent level.

about bank holding company risk exposure in balance sheet data than in income statement data. Our results also suggest that regional differences in bank holding companies' balance sheet composition explain differences in the equity market perception of bank risk exposure.

## Conclusions

Our analysis leads to four major conclusions. First, there is a significant but imperfect correlation between balance sheet data and financial market measures of bank equity risk. In particular, differences in reliance on purchased funds, which result in part from differences in local branching laws, have an important impact on the riskiness of bank equity. This confirms previous findings that uninsured deposits are sensitive to bank risk.<sup>9</sup> Second, the three money center areas exhibited significantly different sensitivities to market and industry sources of risk. New York City bank holding companies are more sensitive to market and industry sources of risks than are bank holding companies in other areas, while



Chicago banks are significantly less sensitive. Third, only the equities of bank holding companies in areas outside of the money centers exhibited sensitivity to interest rate changes. Finally, income statement and loan charge-off data seem to provide little information on the risk sensitivity of bank equity values. This raises questions about the usefulness of off-site monitoring of banks based on published income statements.

<sup>1</sup> See Avery and Hanweck (1984) for a recent study of bank failure, and Barth, Brumbaugh, Sauerhaft, and Wang (1985) for a recent study of thrift-institutions failures.

<sup>2</sup> This view of capital is often referred to as the "accounting" definition of capital. In contrast, the "economic" definition of bank capital focuses on the market value (or net present value) of the bank. These two definitions yield identical values only if all assets (including "goodwill") and liabilities are carried on the bank's balance sheet at their current market values. In practice, however, many bank assets, liabilities, and capital account items are valued on a historical basis rather than at current market values.

<sup>3</sup> Purchased funds are defined as the sum of large time deposits of \$100,000 or more, deposits in for-

eign offices, federal funds purchased and securities sold under agreements to repurchase, commercial paper, and other borrowings with an original maturity of one year or less.

<sup>4</sup> For a more detailed discussion of multi-index market models, see Brewer and Lee (1986).

<sup>5</sup> The risk-free rate of interest is for a security that is free of default and interest rate risks.

<sup>6</sup> Daily return data came from Automatic Data Processing (ADP) data tape. A list of those bank holding companies used in this paper can be obtained from the authors upon request. See Brewer and Lee (1986) for a list of those bank holding companies included in the industry index.

<sup>7</sup> Nearly identical results were obtained using the Fuller-Battese technique for estimating regression coefficients when dealing with cross-section time-series data.

<sup>8</sup> An F test was used to determine if the risk sensitivity coefficients in Equation (1) were significantly different for the three money center areas. The restricted sum of squares was obtained by pooling all the observations into one regression. The unrestricted sum of squares was obtained by summing the error sums of squares for the equations presented in Table 2. The hypothesis that coefficients are equal for the three money center areas can be rejected at the .01 level ( $F_{4,27902} = 30.4$ ).

<sup>9</sup> See Baer and Brewer (1986).

## References

- Avery, Robert B. and Gerald A. Hanweck. "A Dynamic Analysis of Bank Failures," *Bank Structure and Competition*, Federal Reserve Bank of Chicago, 1984, pp. 380-395.
- Baer, Herbert and Elijah Brewer. "Uninsured deposits as a source of market discipline: Some new evidence," Federal Reserve Bank of Chicago. *Economic Perspectives*, Vol. 10, (September/October 1986), pp. 23-31.
- Barth, James R., Dan Brumbaugh, Jr., Daniel Sauerhaft, and George H. K. Wang. "Thrift-Institution Failures: Causes and Policy Issues," *Bank Structure and Competition*, Federal Reserve Bank of Chicago, 1985, pp. 184-216.
- Booth, James R. and Dennis T. Officer. "Expectations, Interest Rates, and Commercial Bank Stocks," *Journal of Financial Research*, Vol. 8 (Spring 1985), pp. 51-58.
- Brewer, Elijah and Cheng Few Lee. "Time Aggregation, Specification, and Bank Stock Rates of Return Determination," March 1986, Unpublished.
- Fama, Eugene F. "Forward Rates as Predictors of Future Spot Rates," *Journal of Financial Economics*, Vol. 3 (September 1976), pp. 361-377.
- Flannery, Mark J. and Christopher James. "The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions," *Journal of Finance*, Vol. 39 (September 1984), pp. 1141-1153.
- Hicks, John R. *Value and Capital*. 2nd Edition, London: Oxford Press, 1946.
- Meiselman, David. *The Term Structure of Interest Rates*, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962.
- Mishkin, Frederic S. "Monetary Policy and Short-Term Interest Rates: An Efficient Markets-Rational Expectations Approach," *Journal of Finance*, Vol. 37 (March 1982), pp. 63-72.